Human-Computer Cloud for Decision Support in Tourism: Approach, Architecture and Scenario

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Outline (1/2)

- Motivation
  - Tourism economics
  - Complexity of tourism domain (for both perspectives)
  - Human and machine functions/activities in TDS
- Analysis of DS in tourism
  - Tourist perspective
  - DMO perspective
  - «Common denominator»
- Human power in DSS types
- Human-computer cloud
  - Approaches and definitions
  - Proposed structure

Outline (2/2)

- Smart Tourism Destination Support Scenario Based on Human-Computer Cloud
  - Introduction
  - Volunteered geographical information
  - VGI Examples
  - Scenario Description
  - Scenario implementation
- Conclusion and future work

CAIS Lab Projects & Grants (2007-2016)

Russian Academy of Sciences

6 projects

Ministry of Education & Science, Russia

МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ
РОССИЙСКОЙ ФЕДЕРАЦИИ

4 projects

Russian Basic Research Foundation

Russian Humanitarian Scientific Foundation

РФФИ

26 grants

1 grant

RSF | Russian Science Foundation

2 projects

Bundesministerium für Bildung und Forschung

1 grant

FP6 IST – 1 project (IP “ILIPT”)

ENPI-Finland - 1 project

NOKIA Connecting People

5 projects

1 grant

FESTO

10 projects

STINT

The Swedish Foundation for International Cooperation in Research and Higher Education

2 grants

Si. Svenska institutet

2 grants

ITMO University' International Lab

- St.Petersburg National Research University of Information Technologies, Mechanics and Optics (ITMO University), more than 10000 full-time students; about 1000 lectures (700 PhD), established in 1900.
- In 2016 the University is ***the 56th in the Times Higher Education Ranking (Computer Science subject).*** The Catholic University of Leuven shares the 56th place with ITMO.
- The University includes ***35 International Laboratories:***
  - **Prof. Alexander Smirnov – a head of *International Laboratory on Intelligent Technologies for Socio-Cyber-Physical Systems (March, 2014),***
  - The Lab staff: Prof., Dr.habil (2); PhD (6); PhD students (4); and Master students (13).

Acknowledgement

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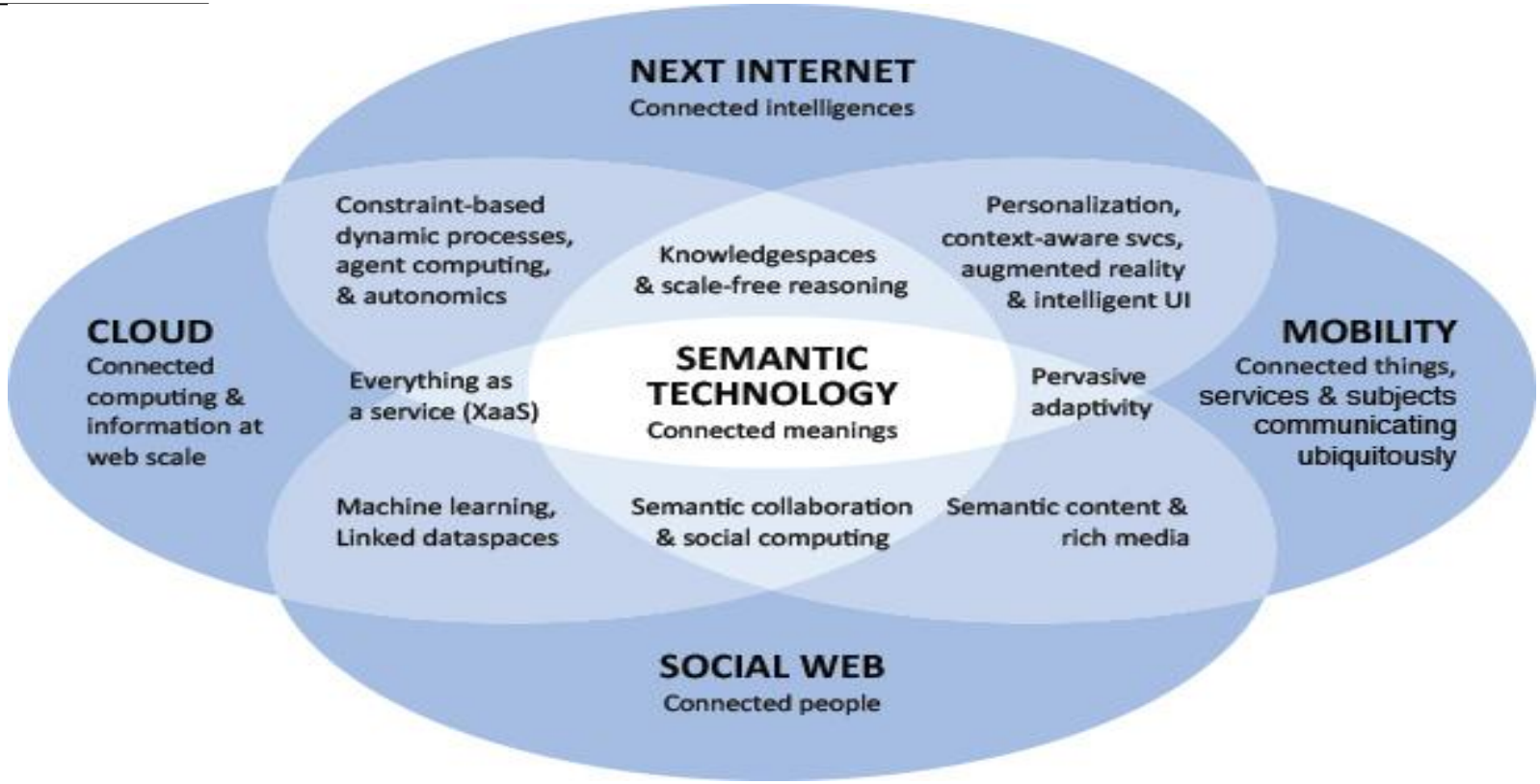
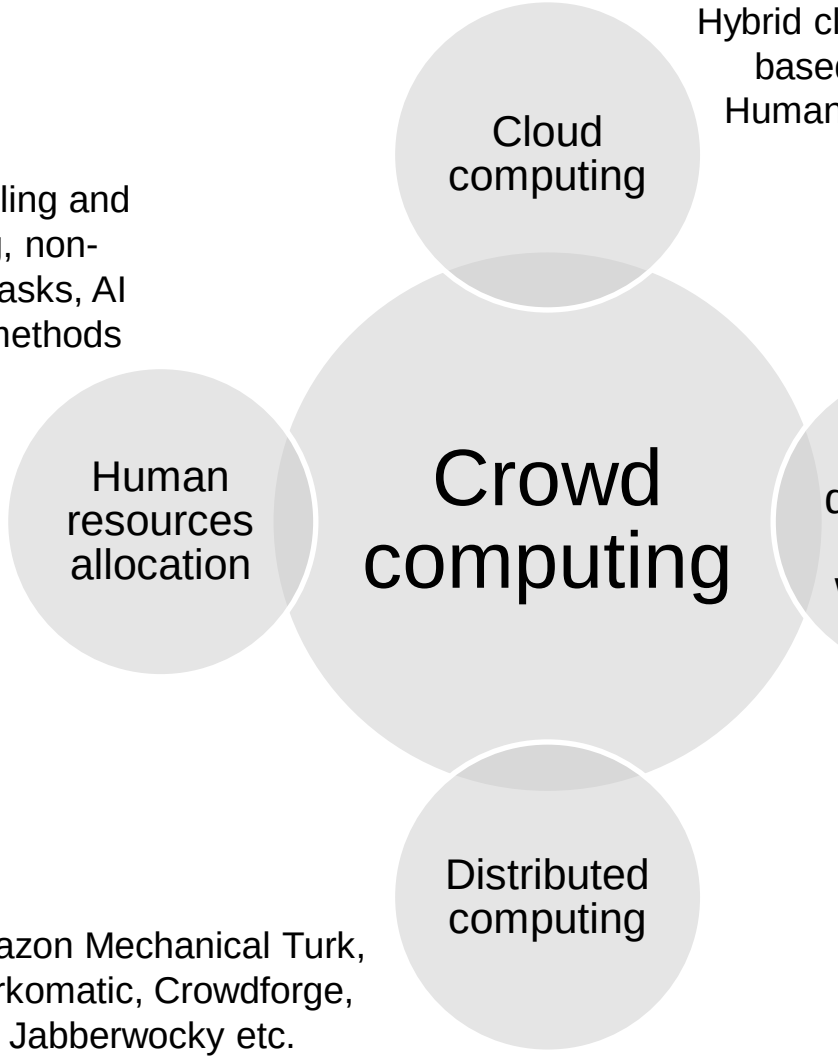
Introduction:
Semantic Technology & Neighbors



- Semantic Technology allows the meaning of and associations between information to be known and processed at execution time.
- For a Semantic Technology to be truly at work within a system, there must be a knowledge model of some part of the world (an active ontology) that is used by one or more applications at execution time.

Introduction:
Related Research Areas



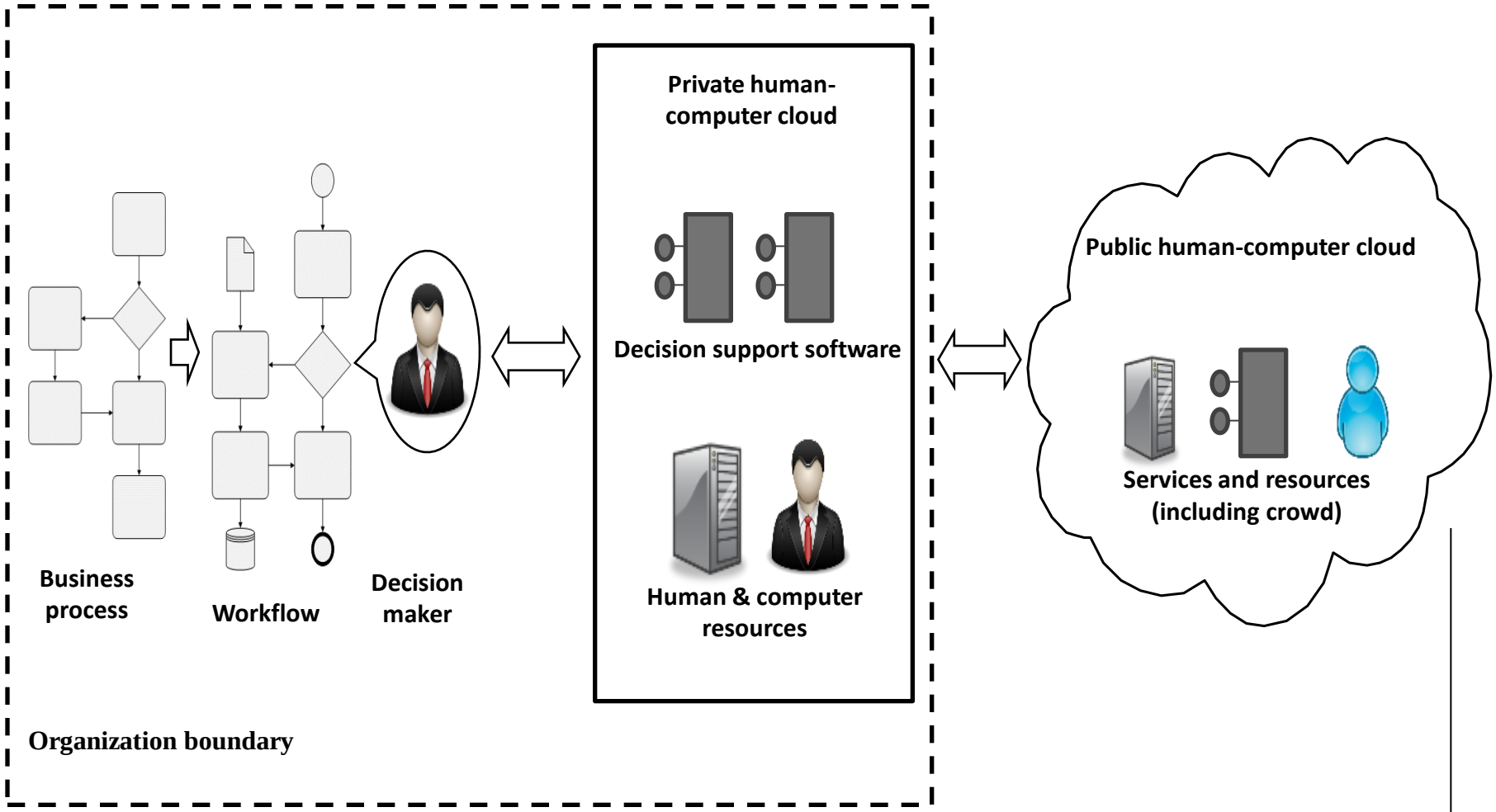
Hybrid clouds of Software-based services and Human-based services

Competencies modelling and linear programming, non-linear programming tasks, AI planning and fuzzy methods

BPEL/BPEL4People/ WS-HumanTask

Amazon Mechanical Turk, Turkomatic, Crowdforge, Jabberwocky etc.

Introduction:
Hybrid Cloud for Decision-Making



Introduction:
Smart Tourism Destination

- The significant development of information technologies introduces new paradigm – smartness – to all spheres of human life. Many services have been developed for providing support for citizens and enchasing the control under cities development while creating technology-embedded ecosystem of Smart City.
- In tourism perspective services, in combination *with cloud computing, human co-operation and Internet-of-Thing technologies*, can improve the effectiveness of tourism resources management throughout the destination and provide so-called *"smart tourism destination"**

* D. Buhalis and A. Amaranggana, "Smart Tourism Destinations," in Information and Communication Technologies in Tourism 2014, Springer, 2013, pp. 553–564.

Motivation:
Glance on Tourism Economics

- Tourism is one of the fastest-growing economic sectors in the world*:
  - International tourist arrivals nearly **doubled** since 1995 and expected to increase by an average of 3.3% a year until 2030
  - International tourism receipts nearly **tripled** for the same period

*) World Tourism Organization, “UNWTO Tourism Highlights 2016 Edition”

Motivation:
Complexity of Tourism Domain

- Tourist perspective:
  - The “postmodern tourist”* with differentiated life-styles, individual motives and specific interests demands products tailored accordingly to stated preferences
  - Large number of aspects that need to be paid attention to: tourist mobility, high risk and uncertainty in unfamiliar environment, distributed nature of information sources etc.
- Destination management organization’s perspective:
  - Need a tool that would help to make decisions about what should be done to make destination more attractive for tourists, to develop a sustainable and profitable tourist economy
    - Highly connected to other economic sectors
    - Sustainable tourism

* Berka, T. and Plößnig, M., 2004. Designing recommender systems for tourism

Motivation:
The Realm of Humans and Machines

Tourist information (and decision) support systems today use a wide spectrum of technologies, including GIS, knowledge-based inference, information retrieval, social network processing and various recommendation systems.

This spectrum includes both machine-driven (solely computational) technologies like GIS or knowledge-based inference and also human-driven ones like recommendation systems.

Motivation:
The Whole Idea

- Identify tasks and scenarios actual for decision support in tourism (from both perspectives, tourist's and DMO's).

- Identify extensions of conventional types of decision support systems with crowd-like human intelligence.

- Implement both on the unifying basis of human-computer cloud.

DS in Tourism: Tourist's Perspective

- To create and maintain personalized travel objectives, preferences, web pages, and evaluation criteria.
- To search and browse tourism-related (factual) information such as destinations and accommodations, attractions and features, package tours and travel agencies, etc.
- To browse analytical information about a destination or its parts.
- To employ the evaluation and selection procedure using pre-specified criteria for choosing tourism products and vendors.
- To receive and browse recommendations of particular places of interest or events.
- To design personalized travel plans (itineraries).
- To find and organize customers of similar interests to exchange ideas.
- To negotiate with tourist operators.

DS in Tourism: DMO's Perspective

- Tracking current situation.
- Measuring travel motivators.
- Gathering competitive intelligence.
- Recognizing new opportunities.
- Evaluating marketing activities.
- Monitoring industry satisfaction.
- Measuring return of investments.

DS in Tourism: Wrapping Up

- The functions analysis confirms that human input plays an important role in tasks of both perspectives
  - Tourist: receive recommendations, browse reviews, design itineraries, connect with similar customers
  - DMO: tracking current situation, measuring travel motivators, evaluating market activities
- Many activities of the both perspectives are similar:
  - Search factual tourism-related information, analytical information, connecting to past visitors, etc.
- Therefore,
  - It is reasonable to have a set of generic services that will be useful for both “perspectives” of the decision support

External Human Intelligence in DSS Types

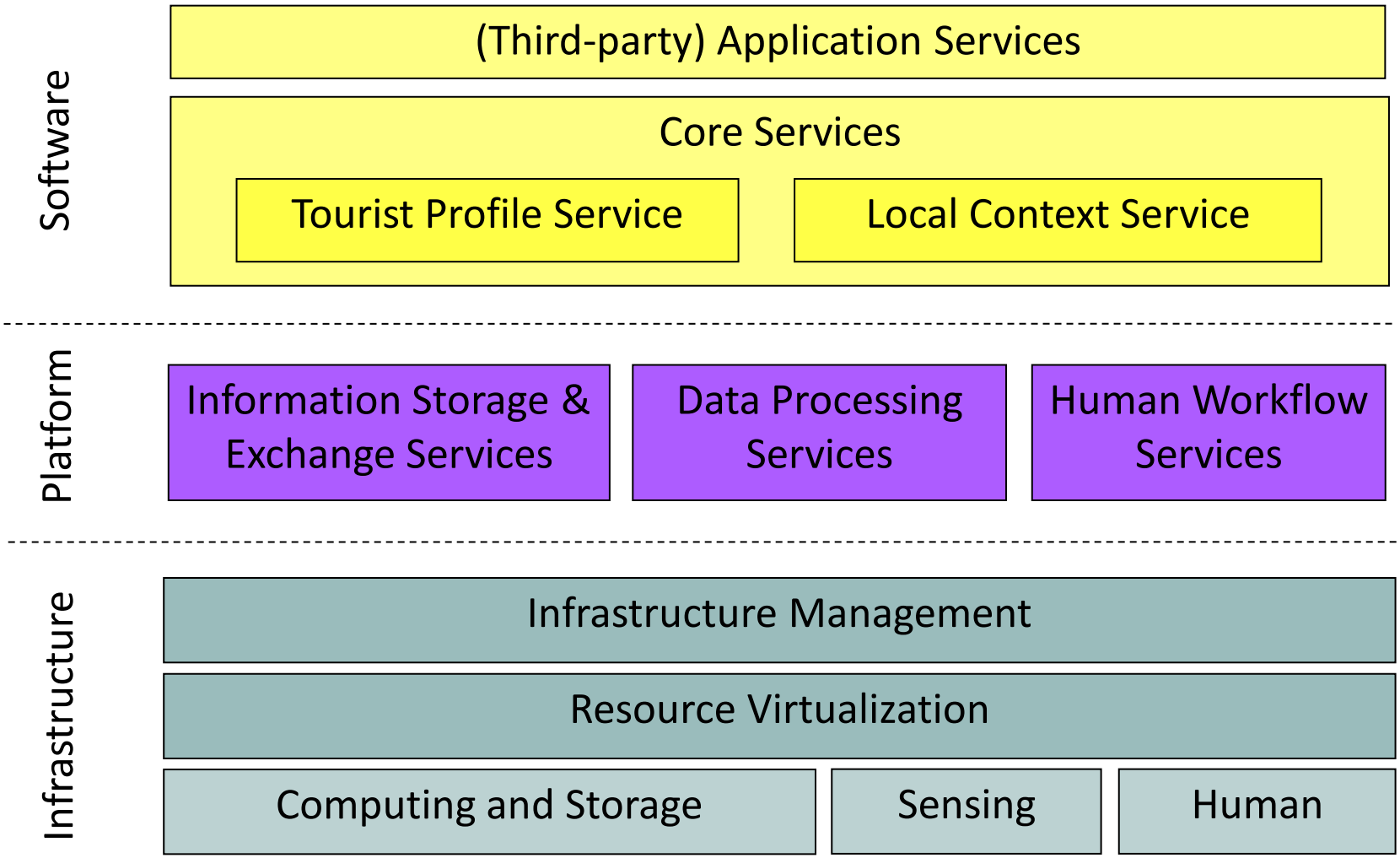
DSS Type	Ways to Use (Crowd-based) Human Intelligence
Data-driven (EIS, OLAP)	- provide "bits" of data to analyze - data cleaning and reconciliation
Model-driven	- propose specific models as a result of a contest - estimate parameters of a model using "expert" judgement
Document-driven	- create/compose documents (Wiki or VGI) - semantic annotation and tagging - Image recognition and audio transcription
Communication-driven and Group DSS	- use contributors as "experts"
Knowledge-driven	- provide domain knowledge - participate in semi-automated knowledge processing mechanisms (ontology matching, inference etc.)

Note: DSS types are provided according to Power D.J. Decision support systems: concepts and resources for managers. Westport, CT: Quorum Books, 2002.

Human-Computer Cloud

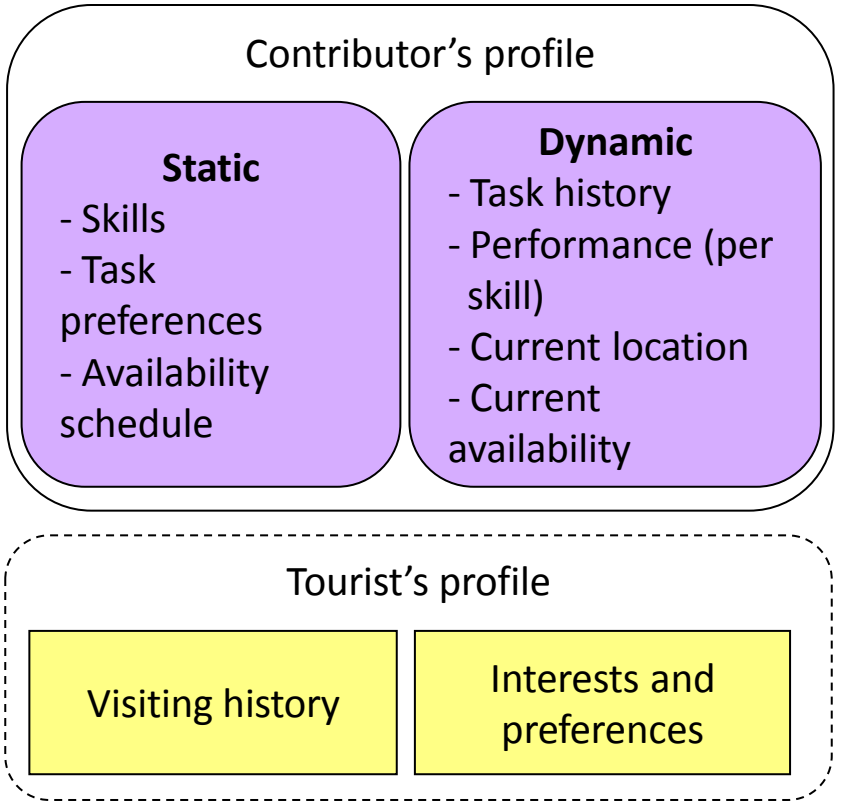
- **Main idea:**
  - Apply resource abstraction and virtualization, inherent in cloud computing for different kinds of resources (e.g., human resources).
- **Why:**
  - Decouple resource management issues from computational systems.
- **Approaches:**
  - IoT-based:
    - ClouT (Cloud + IoT), Smart City Cloud, EU-Japan collaborative project, 2014-2016
    - Sensing and actuation as a service/Mobile crowdsensing as a service, 2012
  - HR-based:
    - Vienna University of Technology (TU Wien), 2012
- Use combination of them (as humans may be processors, not only information providers).

HCC Architecture: Layers



HCC Architecture: Infrastructure Layer

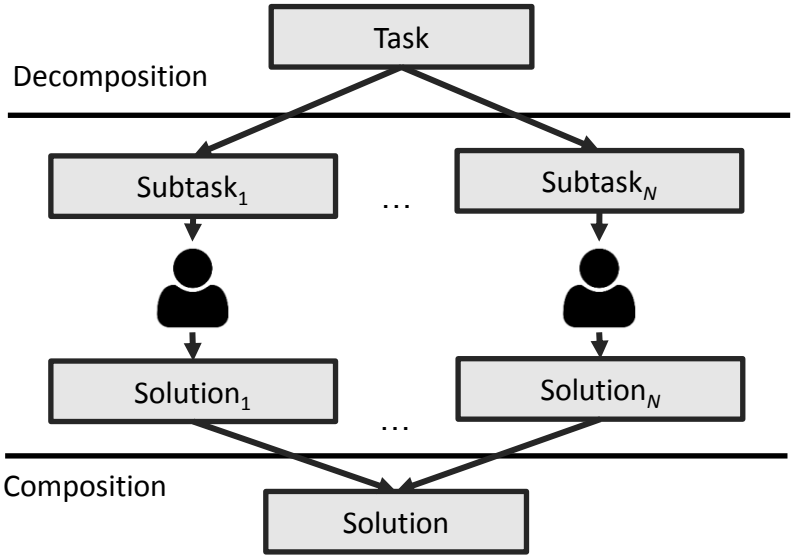
- Management of different capabilities: computing, human, sensing.
- Manages attaching/detaching of contributors:
  - Types of tasks, availability, load restrictions, rewarding.
- Don't have to be locked to tourism.



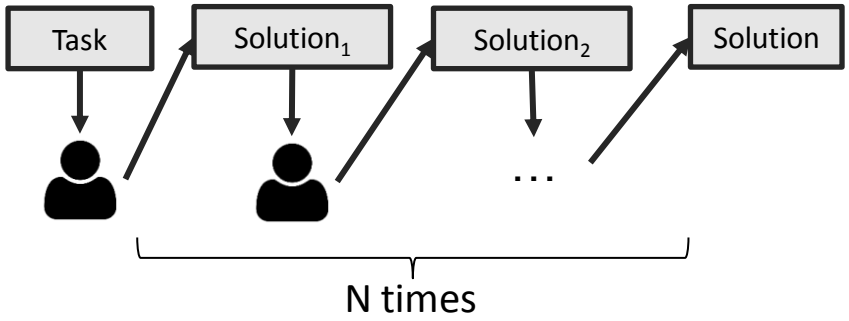
HCC Architecture: Platform Layer

- Scalable information storage and exchange services.
- Data processing services.
- Services for arranging workflows, including human efforts.

"Divide-and-Conquer"



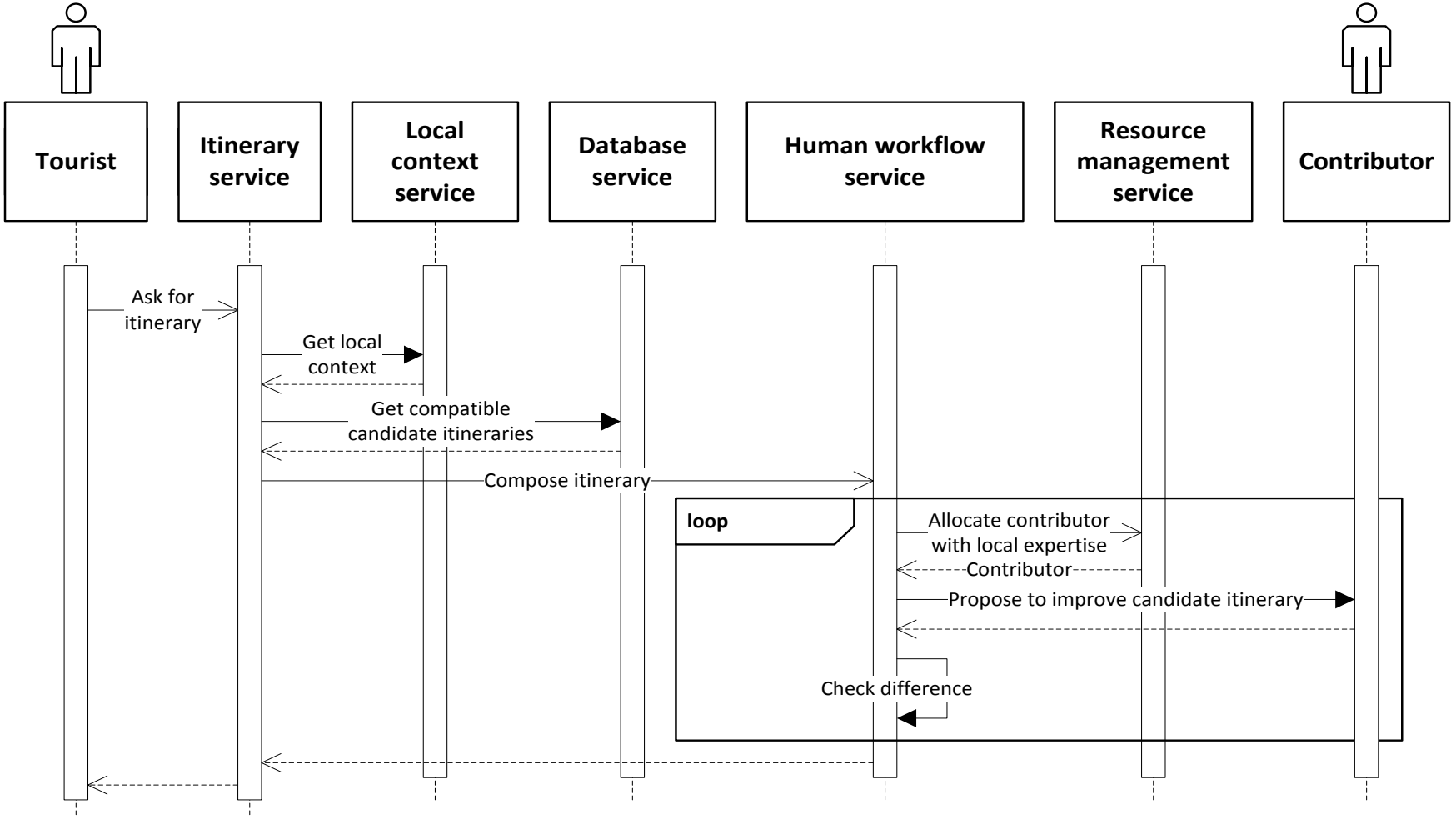
Iterative Improvement



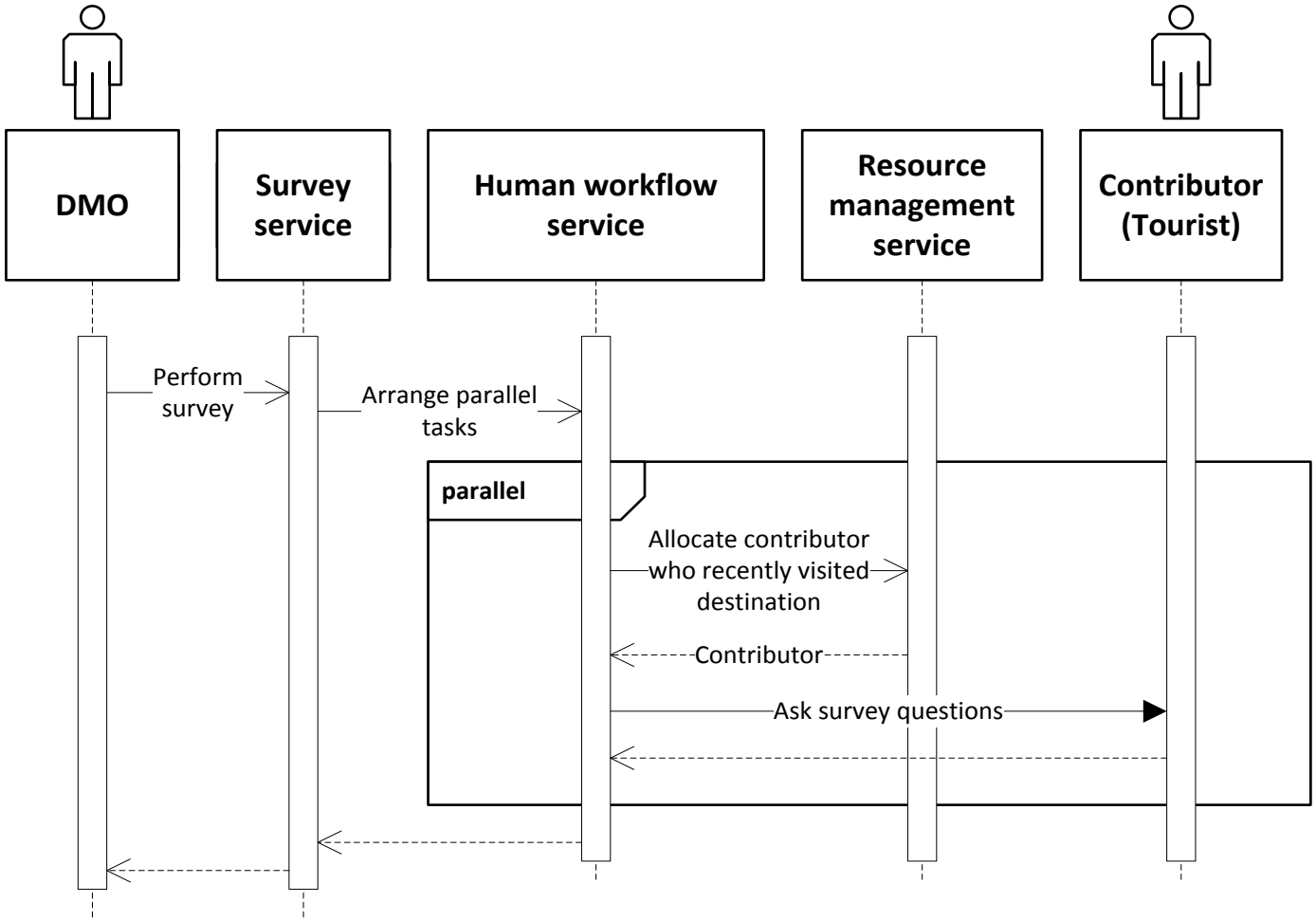
HCC Architecture: Software Layer

- Core services:
  - Profile management service representing a centralized storage of user's history and preferences.
  - Local context service providing various information about current situation in the selected area.
- Application services:
  - Tourist services:
    - Attraction information and recommendation services, itinerary planning, local transport information etc.
  - DMO services:
    - opinion monitoring, usage statistics services etc.

Scenario:
Human-based Itinerary Planning



Scenario: Tourist Survey



Scenario: Smart Tourism Destination Support Based on Human-Computer Cloud

- Smart Tourism Destination:

  *‘‘an innovative tourist destination, built on an infrastructure of state-of-the-art technology guaranteeing the sustainable development of tourist areas, accessible to everyone, which facilitates the visitor’s interaction with and integration into his or her surroundings, increases the quality of the experience at the destination, and improves residents’ quality of life.’’**

- Technologies:
  - Internet-of-Things;
  - Smart City;
  - Cloud computing;
  - Human cooperation in information systems.

*Lopez de Avila, A. (2015). Smart destinations: XXI century tourism. ENTER2015 Conference on Information and Communication Technologies in Tourism, Lugano, Switzerland, February 4–6, 2015

Volunteered Geographical Information (VGI)

- Special case of user-generated content and human cooperation.
- Goal – to create most accurate and actual world map.
- Volunteers are people without specific skills and knowledge in geographic information sciences.
- Early appeared in 2006-2007.
- Main questions in current discussions:
  - Can volunteers provide accurate and complete data? (Yes)
  - Is coverage full or there are a lot of white spaces? (Mostly full)
  - How accuracy depends on volunteers activity?
  - What kind of geographic information is better (more accurate and complete) – proprietary or volunteered? (Proprietary, but with tiny advantage)

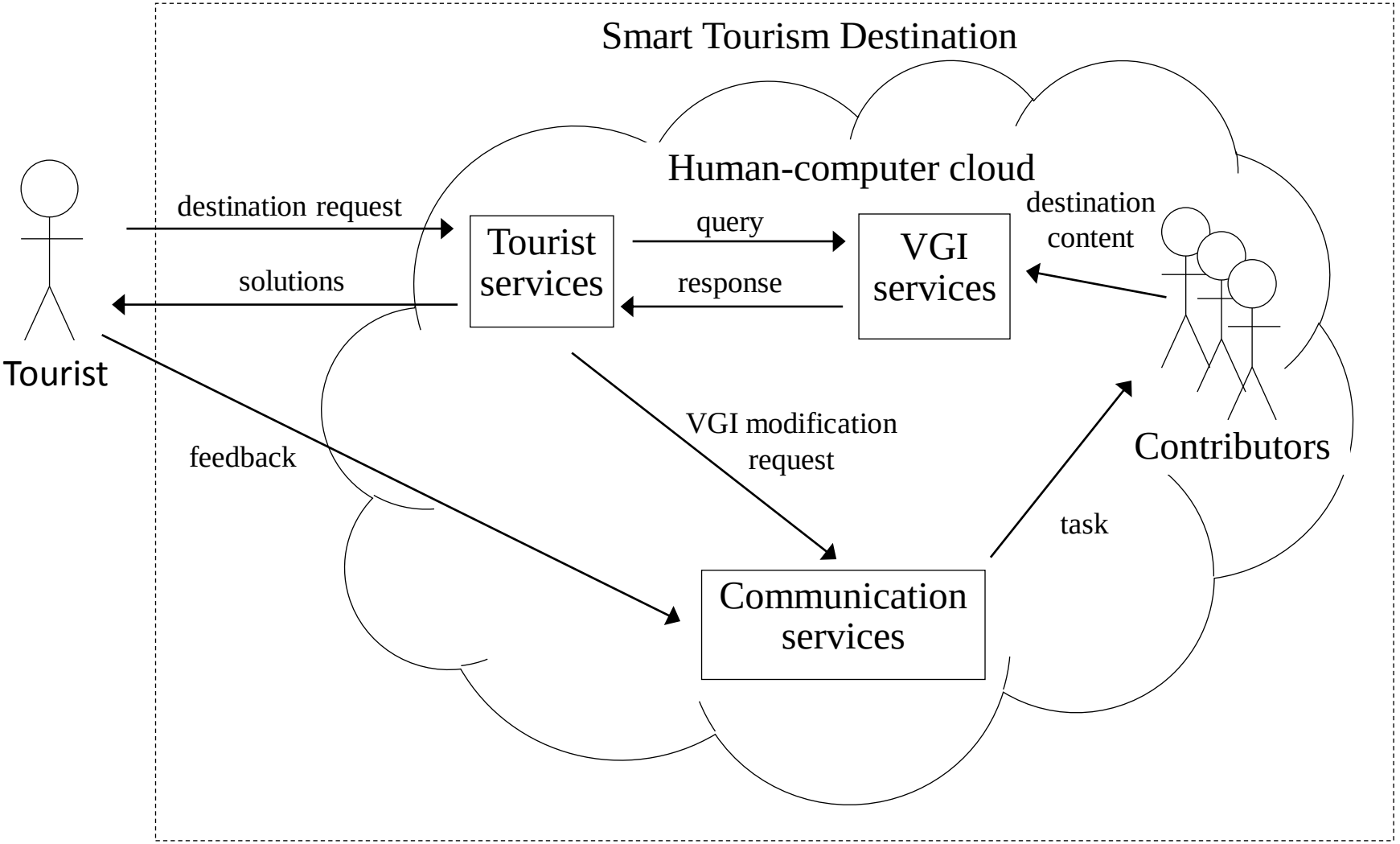
VGI Examples

	OpenStreetMap	Wikimapia
Foundation year	2004	2006
Goal	Creating most accurate world map	Describe the world
Number of contributors	> 3 mln	> 2.5 mln
Object types	Nodes Ways Relations	Polygons with descriptions, photos and links to external sources
Number of objects	3.5 bln nodes 350 mln ways 2.5 mln relations	25 mln polygons

VGI in Tourism Domain

- Two community types:
  - **Local**. People and organizations (DMO) united by territory. Impact to the geographical information allows them be not only venue for organizing local activities, but become promoter of their territory.
  - **Virtual**. Users of global networks. They create “community feeling”: unveil values of local places of interests and built tourist image of smart tourism destination.
- Researches shows that places with attractions has greater number of local and external (virtual) contributors in comparison with places without any points of interest (mostly local contributors). Moreover, number of external contributors can exceed number of local contributors in popular tourism locations.

Smart Tourism Destination Support: HCC Based Scenario

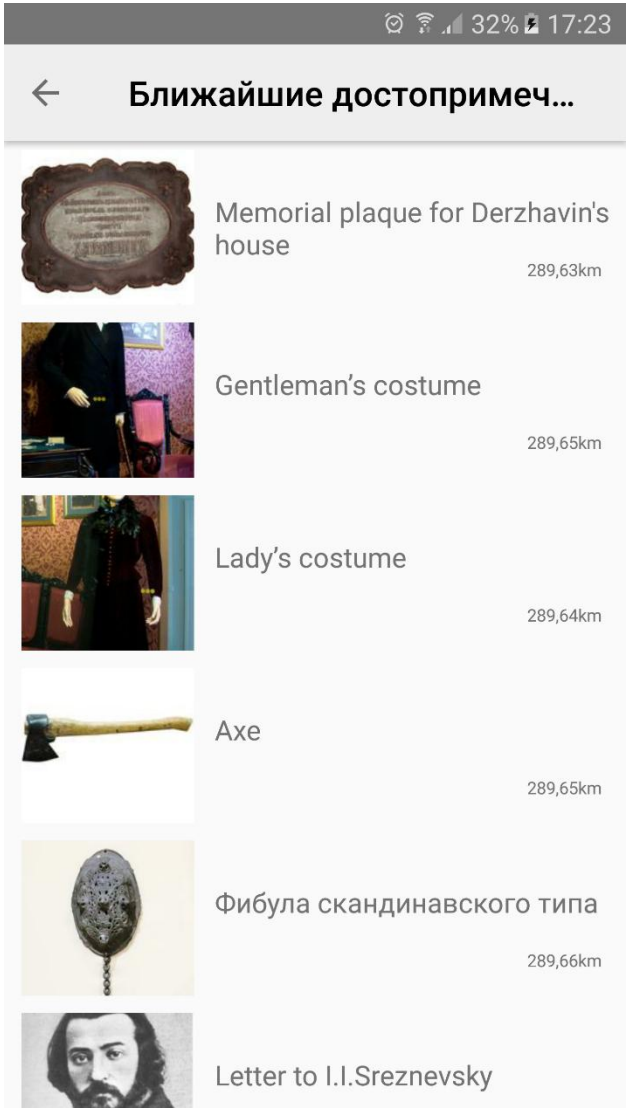


Human Resources

- Tourist:
  - consume content;
  - leave feedback (reviews, ratings);
  - communicate (questions and answers about content).
- Contributor:
  - create content;
  - edit content;
  - moderate content;
  - promote destination.
- Tourist can become contributor and vice versa.

Scenario Implementation

- Presented scenario has been partly implemented on the base of Tourist Assistant – TAIS.
- New information source have been added to the TAIS to provide objects from “Open Karelia” museum system.
- With user ratings objects and museums can be promoted and then placed on the top of the nearest objects list.



Conclusion

- Done:
  - analysis of tasks and operations typical for information and decision support in tourism (both for tourists' perspective and DMO's);
  - a conceptual architecture of a tree-tiered human-computer cloud, addressing these tasks and operations;
  - initial set of scenarios for human-computer cloud usage in tourism.
- Future work:
  - multilevel standardization of human-computer cloud APIs – resource management, platform level and service level, and building an example decision support architecture on the basis of these APIs;
  - models to define the contract between a human contributor and a cloud infrastructure as well as algorithms to follow this contract maintaining high throughput;
  - Communication service implementation.

Thank you!

Questions are welcome!